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New opportunities for sensing using microstructured optical fibres

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Recently a new class of optical fibre has emerged: the microstructured fibre. One example is the holey fibre (HF), which has a cladding region defined by air holes (see Figure 1). Light is guided in a HF due to the effective refractive index contrast between the solid core and the holey cladding. This contrast is typically a strong function of wavelength, and this leads to a host of novel optical properties. [1,2] Microstructured fibres offer new alternatives for sensing, and they can be divided into two categories: those which use the holes directly, and those which exploit their unusual optical properties.

By careful fibre design, as much as 40% of the modal field can be located in the holes in a HF [1], and so these fibres can compactly and efficiently measure gas concentrations. In addition, HFs can be endlessly single-mode, and can have mode sizes ranging over three orders of magnitude. In addition, the zero-dispersion wavelength in a small-core HF can be shifted as low as 550nm, [2] something not possible in conventional fibres. When such a fibre is pumped near this wavelength, a broadband continuum spectrum can be generated, creating new source wavelengths for sensing.

Using a single multiple-core HF, three-dimensional deformations can be monitored. Combining gratings with microstructured fibres opens up potential applications ranging from temperature sensing to gain flattening. [3] Recently magnetic field effects have been used to guide atoms within a microstructured fibre. This provides a route to a new range of ultra-sensitive sensor: for example, atom interferometers would allow gravitational fields to be measured with unprecedented accuracy.

[1] T.M. Monro, W. Belardi, K. Furusawa, J.C. Baggett, N.G.R Broderick and D.J. Richardson, 'Sensing with microstructured optical fibres', Meas. Sci. Tech. (submitted), (2001). and Tanya M. Monro, D. J. Richardson and P. J. Bennett, 'Developing holey fibres for evanescent field devices', Elect. Lett. 35, 1188-1189,1999.

[2] J.K Ranka, R.S. Windeler and A.Stentz, 'Optical properties of high-delta air-silica m icrostructure optical fibres', Opt. Lett. 25, 796-798, 2000.

[3] B.J. Eggleton, P.S. Westbrook, R.S. Windeler, S. Spalter and T.A Strasser, 'Grating resonances in air-silica microstructured optical fibres', Opt. Lett. 24, 1460-1462, 1999. and A.A. Abramov, A. Hale, R.S. Windeler and T.A. Strasser, 'Widely tunable long-period fibre gratings', Elect. Lett. 35, 81-82, 1999.